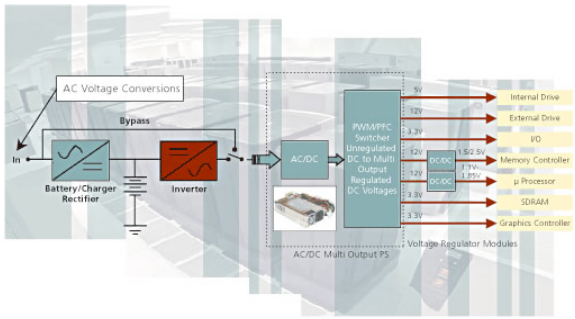
Energy-Efficient Direct-Current-Powering Technology Reduces Energy Use in Data Centers By Up to 20 Percent

BERKELEY, CA —



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In typical data centers, the loss in electrical power through conversions of AC to DC to AC to DC occurs for all power flowing to the IT equipment. Efficiency gains have a magnifying effect by reducing need for HVAC (e.g. 10% saving at the UPS level could mean 20% saving for the data center).
Credit: Berkeley Lab

Researchers at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) have teamed with Silicon Valley giants including Sun Microsystems, Intel, Cisco, and others to demonstrate technologies that could save billions of dollars a year in the energy costs of operating data centers, as well as improve reliability and lengthen equipment life. The demonstration is taking place this summer at a test facility at Sun Microsystems in Newark, CA. More than 20 high-technology companies are participating.

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Eliminating power conversion losses by using DC (direct current) instead of AC (alternating current—from the electricity grid) power to provide electricity throughout the data center can trim the energy needed to run the centers by 10 to 20 percent and improve reliability. Preliminary measurements from the demonstration center in Newark support this estimate.

Researchers in Berkeley Lab's Environmental Energy Technologies Division (EETD) proposed this technology demonstration and the California Energy Commission's Public Interest Energy Research (PIER) program sponsored the work.

The Berkeley Lab team, which consists of project leader William Tschudi, Steve Greenberg, and Evan Mills, conceived the project and provided oversight for the demonstration's planning and design, which is being executed by private-sector firms ECOS Consulting and EPRI Solutions under a contract with Berkeley Lab. The partner companies have provided technical advice, equipment, and staff to set up the demonstration facility.

The demonstration facility will be open to interested parties through August.

Growing energy use in datacenters

Data centers are the backbone of the Internet, providing data storage for websites and databases accessible over the World Wide Web, and supporting virtually every larger sized private corporation and institution.

a mechanical engineer with the Applications Team in Berkeley Lab's Energy and Environmental Technologies Division, is the leader of a project that could save billions of dollars a year in the energy costs of operating data centers, as well as improve reliability and lengthen equipment life.

Data center managers say that the rapid growth in their power and cooling requirements, and the growing cost of electricity, have become a significant concern.

According to a recent report by Berkeley Lab, SEMATECH and other industry leaders ("High-Tech Means High Efficiency"), data centers, which operate 24 hours a day, seven days a week, have among the highest density of energy-consuming equipment of any modern building.

"They can use 100 times the electricity of a typical office building on a square foot basis," says William Tschudi, the Berkeley Lab principal investigator for this project. "Energy costs of $1 million per month are not uncommon in large data centers that require megawatts of electricity."

Such factors as the rapid growth of the web, the increase in the use of networks to help geographically dispersed teams, and increasing server power has led to rapid growth in data centers and in their energy use. Facilities managers, corporate information services departments, and Internet service providers are searching for ways to reduce their energy costs.

"We're excited to be able to demonstrate and evaluate the efficiency merits of two different data center DC power delivery approaches and expect our results can inform data center operators, facility designers and this global industry regarding efficient options for future designs," says My Ton of ECOS Consulting.

DC Power Increases Efficiency and Enhances Reliability

A number of strategies can be used by designers and managers of these facilities to decrease their power needs, such as optimizing airflows to get the most out of the cooling system, upgrading the energy efficiency of the cooling system, or moving to liquid cooling, and facilities managers are increasingly implementing them.

DC power offers a complementary strategy for improving energy efficiency. In the typical data center, the power distribution system provides 480-volt AC power to a transformer, which then steps it down to 208-volt AC, which feeds racks of servers.

Individual power supplies (typically these are redundant) within each server convert this into a voltage appropriate for the unit's needs. These individual supplies are often inefficient, generating substantial heat which the room's air conditioning system must remove at great expense. Waste heat can also impose limits on the number of servers that can be housed in a data center and jeopardizes reliability if not handled properly.

Some servers on the market can run on DC power—typically at 48 volts DC, which is the standard in the telecommunications industry. The demonstration shows how a DC-powered data center could skip the conversion from 480 to 208 volts and provide DC power directly to the servers. The demonstration DC center converts high-voltage AC directly into high-voltage DC power, and then steps down the high-voltage DC power to low-voltage within the IT equipment. By skipping or consolidating conversion steps, this approach can save as much as 20 percent of electricity usage overall.

However, substituting DC power in data centers as a replacement for conventional AC power has not yet made significant inroads into many data centers because the technology is unfamiliar to many facilities engineers. There is reluctance within the industry to switch to new technologies without field experience showing that the switch could be done safely and would have operational and economic benefits, without causing unanticipated problems

The Applications Team Steps In

The Applications Team is a group within Berkeley Lab's EET Division which tackles demonstration projects involving advanced, energy-efficient technologies that have not yet become mainstream in the marketplace. They

target technologies that have great energy-efficiency potential and other advantages (e.g. improved comfort, safety, lower maintenance and operating costs) but need field-testing or demonstration under real conditions to prove these benefits to users. DC-powered data centers were an ideal target technology for the A-Team.

“This project is meant to show that energy savings are possible by minimizing energy conversions within the data center and its equipment. Sun Microsystems, Cisco, Intel, IBM, and many others have been involved, as well as vendors who are eager to sell DC technology solutions to the marketplace,” says Tschudi.

All of the demonstration DC equipment has been loaned by the manufacturers. Sun, Intel, and possibly others will be providing servers to operate on DC power. This project is actually two demonstrations. One shows off a DC architecture at a facility level, distributing 380 volts DC, and the other is a rack-level implementation of DC power supplied at 380 volts within the rack.

The industry participants and the California Energy Commission have formed a stakeholder group that will evaluate the results of the demonstration, document energy savings, and compare the performance of DC-power data centers to conventional centers.

Source / Credit: Berkeley Laboratory